

# DEEP LEARNING BASED BREAKAGE AND CRACKS DETECTION IN RAIL TRACK JOINT BARS

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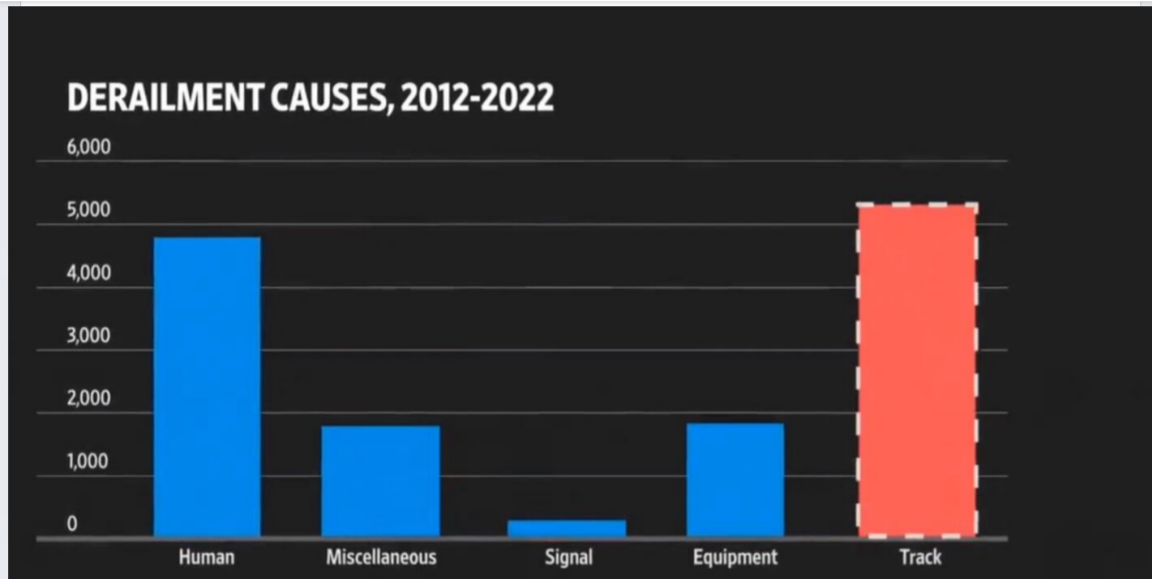
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Human errors and track defects are major contributors  
Safety is paramount - It is not just about Economics

## RAILROAD SAFETY

Railroad safety is a critical aspect of transportation infrastructure that aims at preventing accidents and ensuring the well-being of passengers.



Src: Federal Railroad Administration

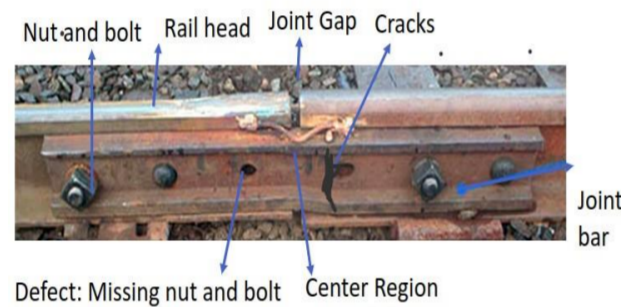
Track inspection is significant to ensure safety and efficiency of railway transportation. There is a huge demand for effective, frequent & non-invasive inspection methodologies.

### Defects in Joint Bars



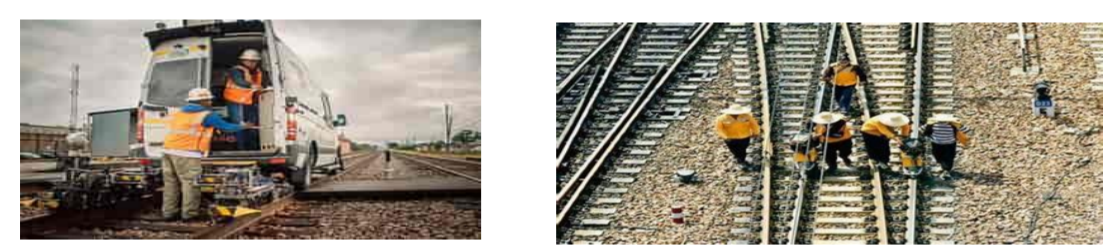
Crack in joint bar

Joint bars, the connecting bar between the rails are critical track elements. These joint bars are vulnerable to cracks and breakages that may lead to derailments.

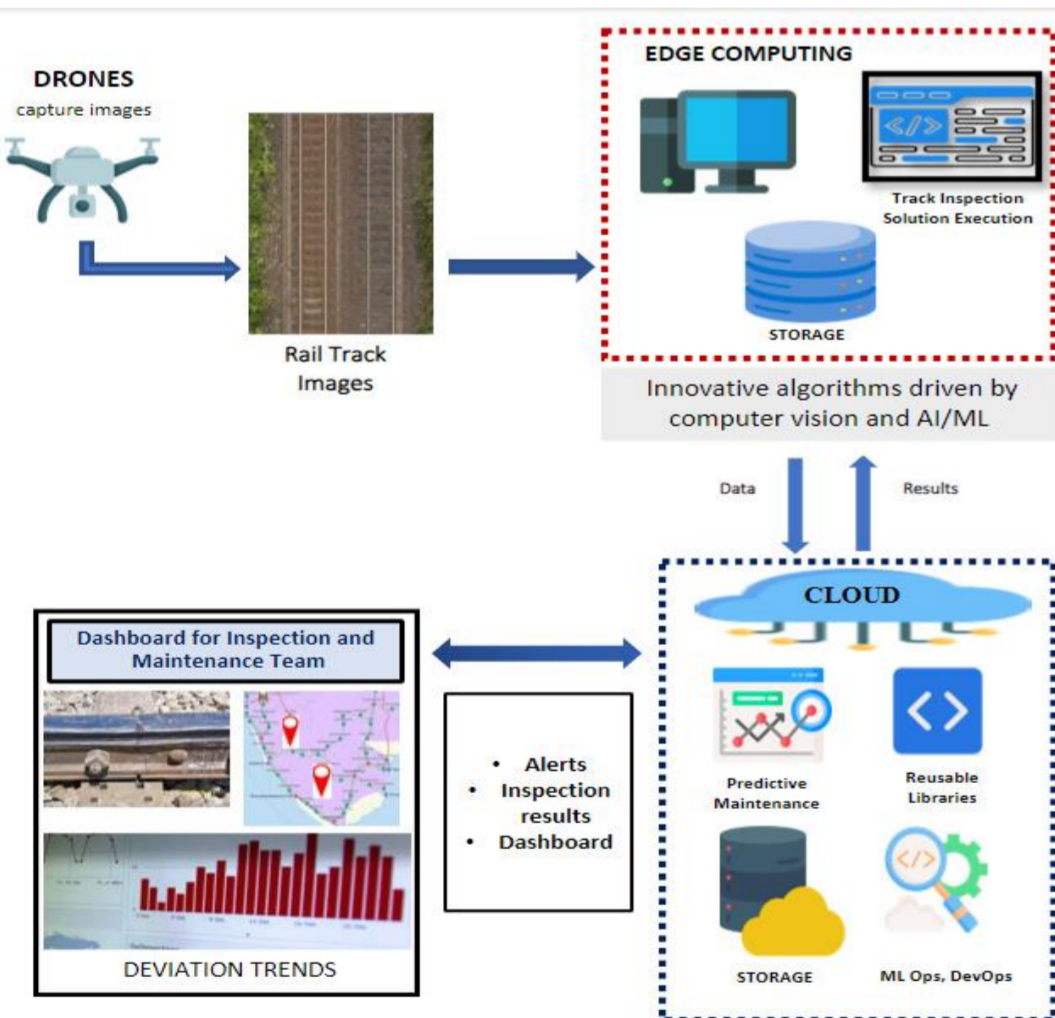


### Conventional Inspection Methods:

Slow, Invasive & Less-frequent



## Intelligent Breakage Detection



High level Architecture of Rail Track inspection solution

Drone based inspection system is a non-invasive technique, in which images can be analysed online or offline for detecting multiple defects. Cloud dashboards can be utilized to analyse historical defect trends.

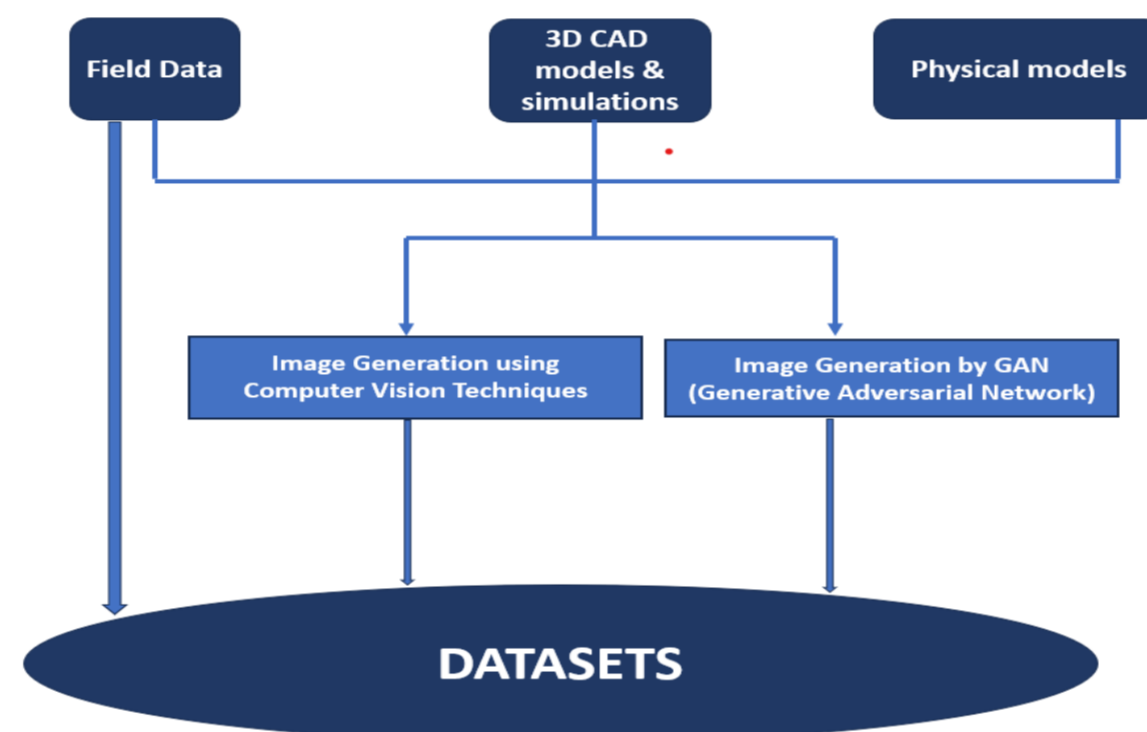
## ALGORITHMS → VGG16, VGG19, ResNet50, DenseNet121, InceptionV3

	VGG16	VGG19	ResNet50	DenseNet121	InceptionV3
SIZE	224 X 224	224 X 224	224 X 224	224 X 224	299 X 299
LAYERS	16	19	50	121	48
PARAMETERS	Approx 138 million	Approx 143 million	25 million	>8 million	Approx 23 million
FLOP	15.5 billion	19.6 billion	4.1 billion	5.7 billion	2.9 billion
SALIENT FEATURES	Fixed size kernel, deep architecture, transfer learning	Fixed size kernel, deep architecture, transfer learning	Residual connections, skip connections	Dense connectivity	Label smoothing, factorized 7 x 7 convolutions, auxiliary classifier

Comparison of classification architectures

The challenges associated with the system are shadows, different environmental conditions and structural variations.

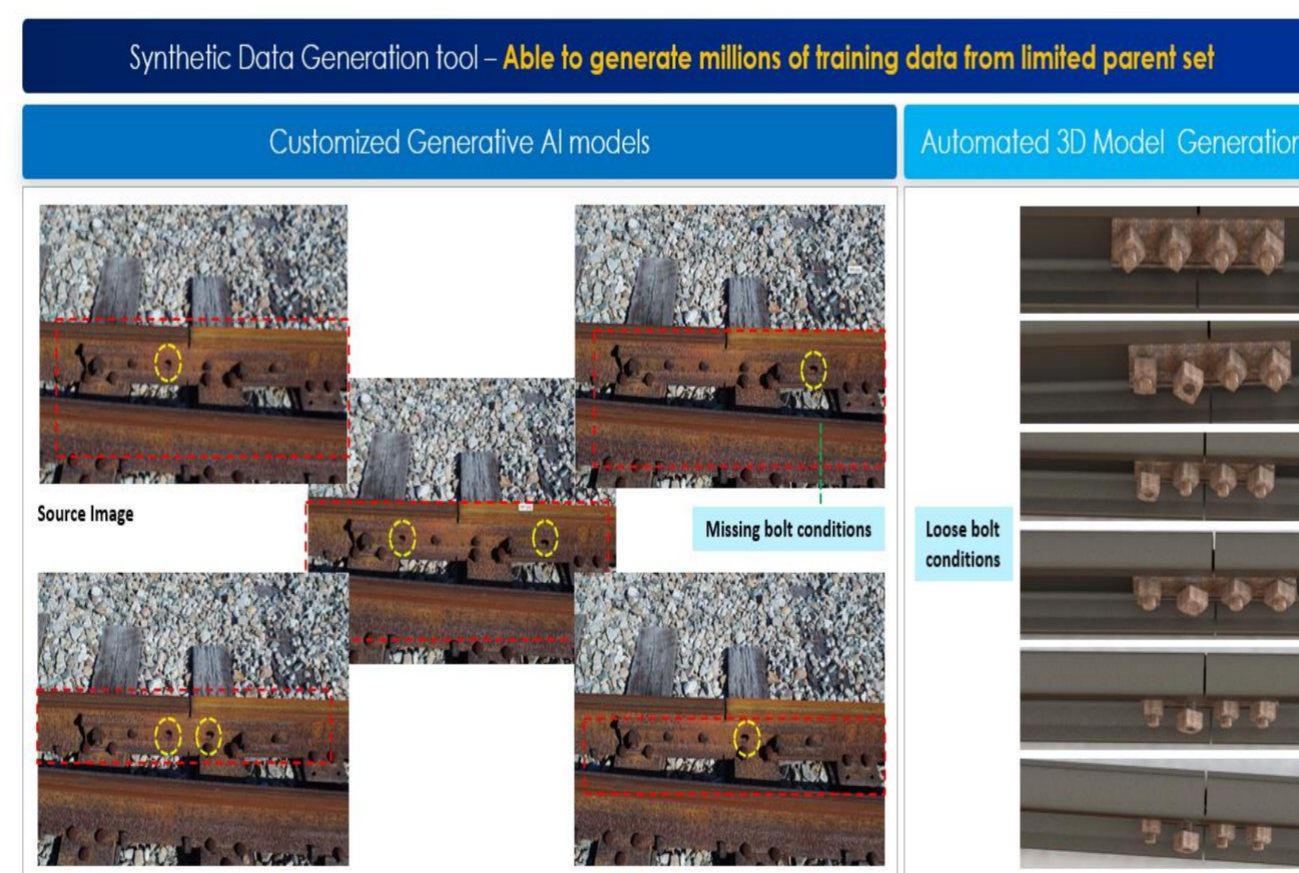
### Dataset Preparation



Tata Elxsi's synthetic dataset generation includes

1. Generating data through customized generative AI techniques.
2. Image generation using advanced computer vision techniques.

The base dataset is collected from the field, that will be used for further data study and generation. For bringing data diversity into training dataset, the potential anomalous data is generated by creating real physical models in lab and through 3D-CAD model's using simulators.



Synthetically generated data samples

## RESULTS

Pre-trained Network	Accuracy	Precision	AUC	F1-Score
VGG16	88.84	88.84	93.90	88.99
VGG19	90.83	90.83	90.70	90.94
ResNet50	71.31	71.31	77.52	71.07
InceptionV3	90.03	90.03	90.99	90.16
DenseNet121	71.31	71.31	72.99	71.22

Comparative performance of pre-trained network

Among the different deep learning methods examined, VGG19 stands out for its remarkable performance when evaluated against other models.

## CONCLUSION

An AI based train track crack detection system is proposed that can detect both minor cracks and big breakages.

The synthetically generated in house dataset is trained with multiple pre-trained deep learning classifiers and among them, VGG19 exhibits high accuracy with least false positives.

Extensive testing, experimentation, and retraining help to achieve models with reliable performance. This intelligent track inspection solution reduces dependability, manpower cost and frequent inspections it also enhances safety and surveillance.

In future, we can increase the overall system performance by adopting ensemble learning techniques, highly customized deep learning models combine the predictions of multiple deep learning models to improve the overall performance.

## REFERENCES

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IRSC 2023

INTERNATIONAL RAIL SAFETY COUNCIL 2023

CAPE TOWN, OCTOBER 1- 6, 2023

